Worldwide Ocean Optics Database (WOOD)

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LONG-TERM GOAL

The long-term objective is to provide a comprehensive worldwide optics database that includes data on a broad range of important optical properties, including diffuse attenuation, beam attenuation, and scattering. The database shall be easy to use, Internet accessible, and frequently updated with data from recent at-sea measurements. The database shall be capable of supporting a wide range of applications, such as environmental assessments, sea test planning, and Navy applications. The database shall include derived optical parameters so that if measured data are not available, the user can obtain values computed from empirical algorithms (e.g., beam attenuation estimated from diffuse attenuation and backscatter data). Error estimates will also be provided for the computed results. Extensive algorithm evaluation and validation will be conducted to ensure that the derived results are optimized as a function of wavelength, season, and geographic location.

OBJECTIVES

A main analysis objective has been to "validate" the algorithms and error estimates to be used in the generation of "Derived Parameters." An on-going objective is to acquire and add new optics data to WOOD. Finally, the data are to be provided to NAVOCEANO.

APPROACH

Validation of derived parameters is being performed for open ocean data, continental shelf data, and shallow coastal data. Multi-wavelength AC-9 data are being used so that the spectral dependence of the algorithms can be assessed. Data from a variety of seasons and locations are being analyzed in order to determine seasonal and geographic dependencies. Our focus is on the inherent optical properties known as absorption (**a**), scattering (**b**), and total beam attenuation (**c**). In an attempt to obtain improved results, the accuracy of published empirical relationships (e.g., Morel's relationships[1] between chlorophyll and optical properties) are compared to new algorithms being developed and tested. The accuracy of each algorithm is assessed in terms of absolute errors (such as the root-mean-square difference between measured and calculated values) and in relative terms (such as the median absolute *percent* error). The absolute error is used to treat high or low values equally. The relative (percentage) error is used to account for the great variability in attenuation coefficients as a function of depth.

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14. ABSTRACT
The long-term objective is to provide a comprehensive worldwide optics database that includes data on a broad range of important optical properties, including diffuse attenuation, beam attenuation, and scattering. The database shall be easy to use, Internet accessible, and frequently updated with data from recent at-sea measurements. The database shall be capable of supporting a wide range of applications, such as environmental assessments, sea test planning, and Navy applications. The database shall include derived optical parameters so that if measured data are not available, the user can obtain values computed from empirical algorithms (e.g., beam attenuation estimated from diffuse attenuation and backscatter data). Error estimates will also be provided for the computed results. Extensive algorithm evaluation and validation will be conducted to ensure that the derived results are optimized as a function of wavelength, season, and geographic location.

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Empirical algorithms will be developed using data from the Sea of Japan, the Yellow Sea, and the Gulf of Oman/Persian Gulf regions. Specifically, we will examine the ratio of the diffuse attenuation coefficient (K) to c and the b:c ratio. The best available data will be used to develop these algorithms (though some of these data cannot be posted on the WOOD public website). JHU/APL already has high quality optical data for the Middle East sites, and Yellow Sea data should be available in the near future. In addition, Greg Mitchell has provided JHU/APL with Sea of Japan data acquired as part of a major ONR field program begun there recently.

Besides these important datasets, many others are being provided by ONR Principal Investigators or are being downloaded from various public websites. Table 1 lists some of the data available for processing and loading into WOOD.

Table 1. Example of Datasets Available to Process & Load into WOOD

Dataset Description	Contents (Location, Number of Profiles, Data Format, etc.)
UCSD Jes9906	Sea of Japan CTD, MER, ac9 [N=44, SeaBass fmt]
ECOHAB	W Florida Shelf CTD, c660, ac9, bb(lamda) [N~ 35]
Bigelow “NOAA”	G_Maine/George’s Bank CTD, ac9 [93 casts; SeaBass fmt]
OSU “Seasoar”	CMO Paravane data CTD, ac9 [N = ***25,633*** !!]
OSU CoBOP	Lee Stocking Island Yr2000, CTD, ac9 [43 one depth; SeaBass fmt]
Sosik G_Maine	G_Maine SPMR, Clor_a+phae, Nutrients, … [N= 88, ProSoft fmt]
Kiefer/Russian	Mediterranean Sea CTD, chlor [N= 450, Microsoft Access fmt]
GLOBEC	G_Maine CTD, fluorometer, c, [N=350]
MBARI	S China Sea SPMR [N=30, SeaBass fmt]
CARIACO	Carib Sea CTD, c, Ed, Lu, Es(lamda) [N ~ 10, SeaBass fmt]
AMLR2000	Southern Ocean MER, K [N = 26, SeaBass fmt]
Siegel/CALVAL	Near Bermuda Chlor+Phaeo [N=379, SeaBass fmt]
Siegel/Plumes&…	SoCal ac9, CTD,TSRB, Hydroscat, etc. [N= 101, Wetview ac9 fmt, etc]
ML Dec94	Panama City ac9, CTD [N=14 WetView & CSS fmt]
ML Aug 95	Panama City ac9, c532, T, Fluor, b(170º) [N=20, MiniOPS fmt]
ML Sep 96	Panama City MER (Ed & Lu), CTD [N=25, Biospherical fmt]

WORK COMPLETED

1. Empirical Algorithms: The focus this year has been on assessing the dependencies of empirical algorithms on location (e.g. open ocean versus continental shelf regions) and wavelength. As an example of this work, Figure 1 shows a summary of b:c ratios as a function of depth, season (deployments 1 to 4), and wavelength. Above 500 nm, the b:c ratio is nearly constant (about 0.80 to 0.85) for these continental shelf data, and this ratio is about the same as for typical open ocean data (where b:c = 0.86). However, at shorter wavelengths the b:c ratio drops off rapidly in the shelf data. This change is attributed to Colored Dissolved Organic Materials (CDOM). On-going work will establish whether the “mean slope” shown in Figure 1 is typical or needs to be adapted in other geographic regions of US Navy interest (such as the Sea of Japan and the Yellow Sea).

2. Provide NAVOCEANO with all original (non-derived) WOOD data: WOOD data were converted to the Microsoft Access database format specified by NAVOCEANO and delivered on CD-ROM in March 2001.

3. Add New Datasets to WOOD: Numerous datasets were received and are in various stages of processing. Those datasets completely processed and added to WOOD include bio-optics data from the Gulf of Maine "Regional Marine Research Program (RMRP)", the Chesapeake Bay Outflow Program (COPE96), and the OSU Coastal Mixing and Optics (CMO 96 & 97) program. Figure 2 provides an example of the large volume of new, high-quality data being added to WOOD.

4. Improve Design of WOOD: We completed a prototype 3-tier system to replace the old 2-tier system. The new design separates the Database, Server, and Client. The new design also incorporates improved query functions such as the ability to:

- Query by Cruise ID
- Query by Number of Points in a Profile
- Query by Subsets of Available Search Criteria (greatly speeds up uncomplicated queries)

Related to the new database design was a new requirement to move the WOOD server outside the APL firewall due to computer security issues. This move was completed in May 2001, and the system is now running on a new 1 GHz Pentium III Processor.

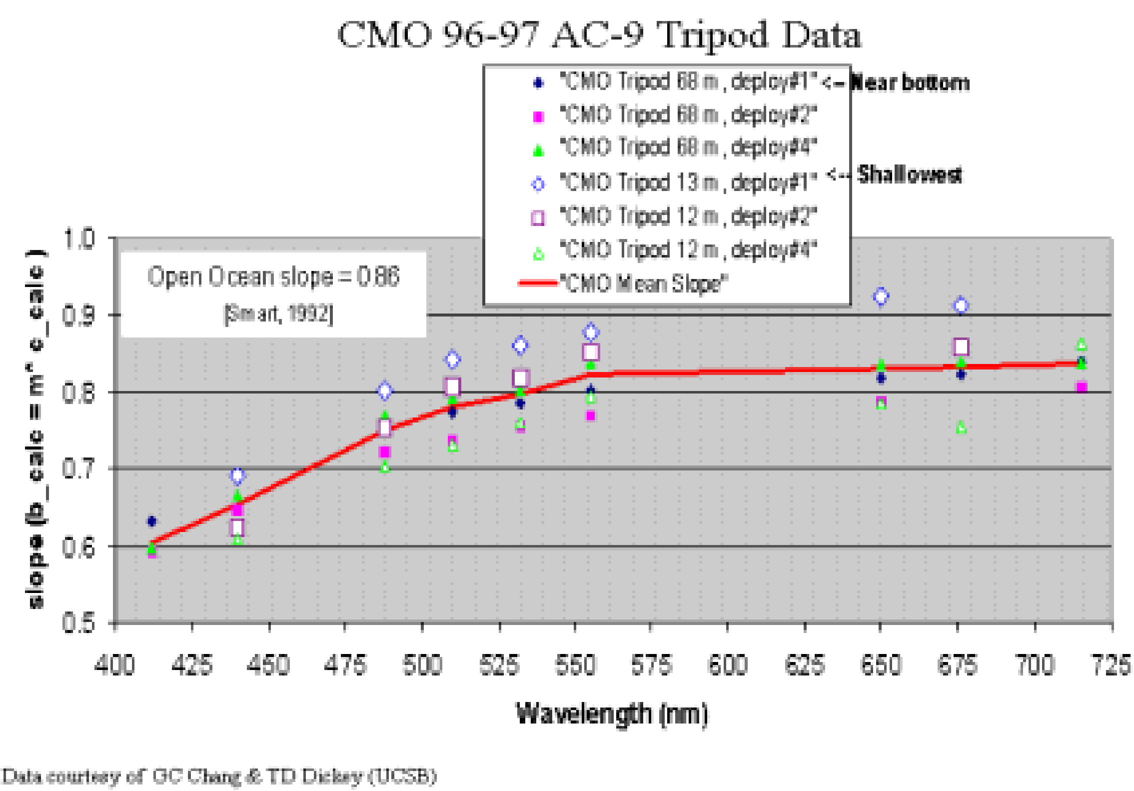

Figure 1. Wavelength Dependence of b:c Ratio versus Wavelength.
[b:c is approximately 0.82 at wavelengths from 550 to 715 nm; b: c decreases to ~ 0.6 at 410 nm]

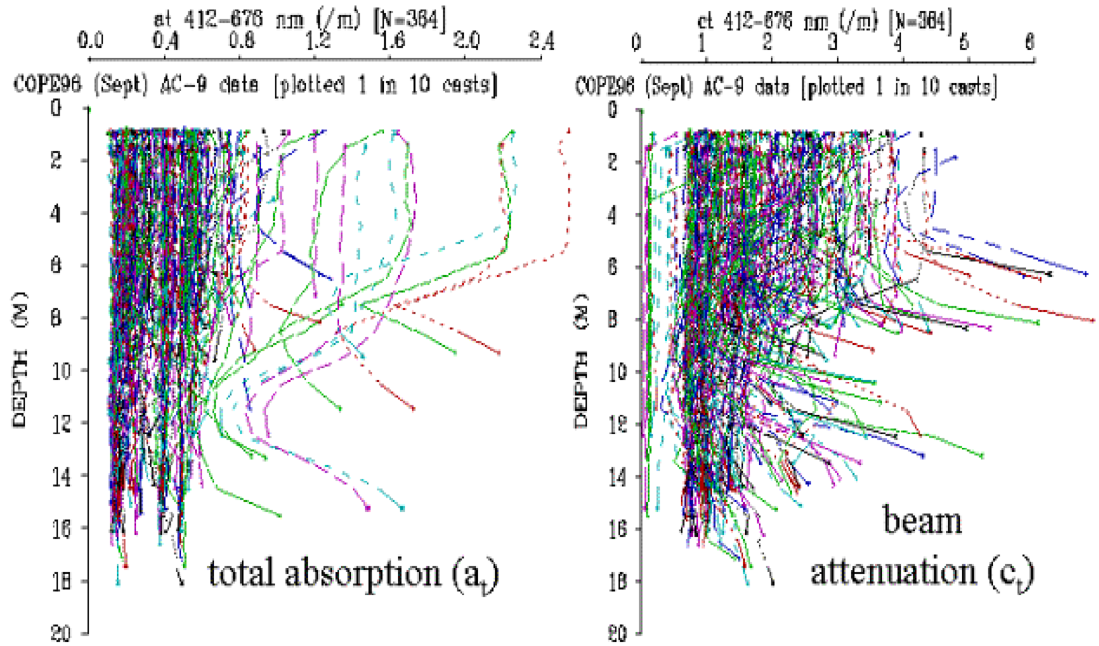

Figure 2. COPE96 Absorption (a) and Beam Attenuation (c) Data Added to WOOD.

RESULTS

Many investigators from around the world have already made use of the WOOD. For example, over a one-year period (March 6, 2000 to March 6, 2001), WOOD was accessed 6,150 times by 1,193 unique IP addresses. (Or about 17 times per day by five unique users per day.) These users included at least 57 different DoD/US government/US DoD contractors and at least 117 educational agencies and schools (research institutes, universities, colleges, etc.). As an example, the ONR Littoral Warfare Advanced Development (LWAD) Program used WOOD data in planning for the LWAD 01-2 Sea Test in the East China Sea.

IMPACT/APPLICATION

The availability of a single location, uniform-format optics database has already saved the US Navy thousands of dollars in test planning and other naval applications. By providing the Navy and the research community with this resource, both types of users benefit from improved knowledge of the optical properties of the ocean. Access to historical optics data can also be useful for assessing newly acquired data. One can compare the two to see if the new results are atypical, and if so, one might go on to determine the cause (e.g. unusual forcing conditions, influx of a different water mass, or perhaps even an instrument calibration problem).

TRANSITIONS

The WOOD data were successfully transferred to NAVOCEANO. In addition, a clone of WOOD (called FAST TACTIC) was developed and deployed on a US submarine conducting a 90-day mission. A similar clone is currently being developed for the Advanced Processor Build (APB) November 2001 sea test as part of the ARCI Environmental Workstation. For related information at the unclassified level, see the Submarine Operational and Research Database (SOARED) website at http://wood.jhuapl.edu/soared/welcome.htm

RELATED PROJECTS

The Laboratory has recently become an official member of the NASA “SEABASS” community that has access to proprietary bio-optics data. In order to obtain this privilege, US Navy permission was obtained to provide unclassified ONR LWAD optics data (collected by JHU/APL scientists) to SEABASS. The first LWAD dataset has been obtained from the East China Sea and exhibits very interesting structure. Finally, the Ocean Biogeographical Information System (OBIS), which is being funded by the National Ocean Partnership Program (NOPP) and by the Census of Marine Life (CoML), is intended to provide an internet-accessible database with a graphical user interface (GUI) that is similar to that already provided by the WOOD. The OBIS steering committee has included Jeffrey Smart (the WOOD Principal Investigator) in their workshops and a paper describing WOOD and how its features might benefit OBIS has been published (see Publications below).

REFERENCES

WOOD Website: http://wood.jhuapl.edu

[1] Morel, Andre," Optical Modeling of the Upper Ocean in Relation to its Biogenous Matter Content (Case I Waters) JGR Vol. 93, No. C9 pp 10,749-10,768) Sept 1988

PUBLICATIONS

World-wide Ocean Optics Database (WOOD), *Oceanography*, Vol. 13, No. 3, pp 70-74, 2000